GEOTECHNICAL INVESTIGATION
VA Vertical Expansion Building 108 and
Parking Garage B
2002 Holcomb Boulevard
Houston, Texas

Reported to:
PAGE SOUTHERLAND PAGE, LLP
1100 Louisiana, Suite One
Houston, Texas

Prepared by:
Geoscience Engineering
and Testing, Inc.
Houston, Texas

PROJECT NO: 12G19759

September 2012

September 6, 2012

PAGE SOUTHERLAND PAGE, LLP
1100 Louisiana, Suite One
Houston, Texas 77030

Attention: Mr. Brian Gray, AIA

Reference: Geotechnical Investigation
VA Vertical Expansion Building 108 and
Parking Garage B
2002 Holcomb Boulevard
Houston, Texas
GETI NO: 12G19759

Dear Mr. Gray:

GEOSCIENCE ENGINEERING & TESTING, INC. is pleased to submit this report for the above referenced project. This study was authorized by you on March 08, 2012. This report briefly describes the procedures employed in our investigation and presents the conclusions and recommendations of our studies.

We appreciate the opportunity to work with you on this phase of the project. If you have any questions concerning this report or require additional information, please contact us.

With Kindest Regards,

Ronald L. Dilly

Ronald L. Dilly, Ph.D., P.E.
Principal Engineer

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I. INTRODUCTION

Geoscience Engineering and Testing, Inc. (GETI) hereby submits this report of geotechnical investigation of subsurface conditions at the site of the proposed VA Expansion Building 108 and Parking Garage B Department of Veteran Affairs Michael E. Debakey VA Medical Center located at 2002 Holcomb Boulevard in Houston, Texas. GETI's investigation was authorized by Mr. Brian Gray with PageSoutherlandPage on March 08, 2012.

The purpose of the geotechnical investigation was to determine the subsurface soil conditions at the site of the proposed 2-story medical office building and 6-story parking garage with particular reference to the recommendations for the design of the foundation for the structure.

It is our understanding that the approximate footprint of the proposed garage is 120-feet wide by 250 feet long. This proposed garage is a 6-level cast-in-place concrete parking garage structure (slab on grade plus 5-elevated levels.). Parking will be provided on the first level with a current finish grade elevation closely corresponding to existing grade. Also, GETI understands that the parking structure column loads are based on 6 levels with a typical bay of 60 feet by 24 feet. The corresponding column dead load, DL, is defined as 950 kips.

GETI understands that the approximate footprint the proposed office building is 100-foot wide by 130-foot long. The office building column loads are base on 2 levels with a typical bay 35 feet by 35 feet. The corresponding column dead load and live load are defined as 130 kips and 115 kips, respectively. Office building wall loads are defined as, DL = 6.6 KLF, and LL = 2.2 KLF.

II. SUBSURFACE EXPLORATION

1. General

This report presents the results of our soil exploration and foundation analysis for the proposed VA Vertical Expansion Building 108 and Parking Garage B located at 2002 Holcomb Boulevard in Houston, Texas.

Scope of this investigation included a reconnaissance of the immediate site, the subsurface exploration, field and laboratory testing, an engineering analysis and evaluation of the subsurface materials. The purpose of this subsurface exploration and analysis was to determine soil profile components, the engineering characteristics of the subsurface materials and to provide recommendations and criteria for use by design engineers and architects in preparing the designs.

The exploration and analysis of the subsurface conditions reported herein are considered in sufficient detail and scope to form a reasonable basis for the recommendations. The recommendations submitted are based on the available soil information and the preliminary design details furnished by with Mr. Brian Gray, AIA, with PageSoutherlandPage, LLP. Any revision in plans for the proposed VA Vertical Expansion Building 108 and Parking garage B located at 2002 Holcomb Boulevard in Houston, Texas from those enumerated in this report should be brought to the attention of the soil engineer, so that he may determine, if changes in the recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the soil engineer.

2. Description of the Site:

The site of the proposed Expansion Building 108 and Parking garage B, upon which this subsurface exploration has been made, is located at 2002 Holcomb Boulevard in Houston, Texas. The proposed Expansion Building site is relatively flat with topographic variation of 2 feet with an area of this site covered with mowed grass and trees, and the remaining portion of the site covered with about 7-inches of concrete pavement on a parking area. The proposed Parking Garage site is relatively flat with topographic variation of 2 feet, with an area of this site covered with mowed grass islands and trees, and the remaining portion of the site covered with about 7-inches of concrete pavement on a parking area.

3. Field Investigation

The field investigation, which was completed on April 14 and 22, 2012, was to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the exploratory borings and recovering the representative soil samples. Due to presence of structures, soil test borings were drilled in the area accessible to drill rig.

The subsurface soil conditions were explored by advancing and sampling eight (8) soil borings. The soil borings B-1 through B-5 were drilled to a depth of thirty (30) feet beneath the existing surface within the locations of the proposed parking garage and the soil borings B-6 through B-8 were drilled to a depth of twenty (20) feet beneath the existing surface within the locations of the proposed building. The approximate soil boring locations are shown on the attached soil Boring Plan, Plate No. 1A for the proposed parking garage, and Plate 1B for the proposed building.

Sample depth and description of soil classification (based on the Unified Soil Classification System) are presented on the Soil Boring Logs, Plate Nos. 3 through 10. Keys to terms and symbols used on the soil boring logs are shown on Plate No. 11.

The soil borings were of three-inch nominal diameter. Both relatively undisturbed and disturbed soil samples were obtained at two (2) feet intervals continuously to a depth of ten (10) feet and at five (5) feet intervals thereafter. The soil borings were performed with a drilling rig equipped with rotary head conventional solid-stem augers were used to advance the holes. Representative disturbed or undisturbed soil samples were obtained employing thin-walled sampling procedures in accordance with ASTM D-1587. The obtained soil samples were extruded from the tube and visually classified in the field. Soil samples were identified according to the boring number and depth and wrapped in aluminum foil and polyethylene plastic wrapping bags to prevent moisture loss and disturbance. All of the samples were transported to our geotechnical laboratory for examination, testing and analysis. All borings were backfilled after final water readings were obtained with the soil cuttings accumulated during the drilling operation unless noted otherwise on the soil boring logs.

3.1 Field Strength Tests:

During the field boring operation, samples of the cohesive soil from the thin-walled tube were frequently tested in compression by use of a calibrated soil penetrometer to aid in determining the strength of the soil.

3.2 Water Level Measurement:

The information in this report summarizes condition as found on the date the borings were drilled. Groundwater was encountered in the Boring B-1 through B-8 during drilling at depths ranging from 16 to 18 feet below the surface during the drilling operation. Long-term monitoring of the groundwater level was beyond the scope of this study. It should be noted that the groundwater table may be expected to fluctuate with environmental variations such as frequency and magnitude of rainfall and the time of the year when construction begins.

4. Surface Fault:

A surface fault investigation is beyond the scope of this investigation; however, the project is not in the proximity of a fault line based on a map "Principal Faults in the Houston, Texas, Metropolitan Area" by Sachin D. Shah and Jennifer Lanning-Rush, U.S. Department of Interior, U.S. Geological Survey. It should be noted that the coastal plains in this region has a complex geology, which included active surface faulting.

5. Laboratory Testing:

In addition to the field investigation, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing their behavior under the proposed loading conditions. During the laboratory investigation, all field soil samples from the boring were examined and classified by a soil engineer. Laboratory tests were then performed on selected soil samples in order to evaluate and determine the physical and engineering properties of the soils in accordance with the prescribed ASTM standards and methods. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Moisture Content and In Situ Dry Density of Soils	ASTM D 2937
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318

Standard Test Methods for Amount of Material in Soils Finer than No. 200 Sieve	ASTM D 1140
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading	ASTM D2435

Strength properties of the soils were determined by means of unconfined compression tests performed on undisturbed samples. The type and number of the laboratory tests performed for this investigation are:

DESCRIPTIONS	No. of Test	DESCRIPTIONS	No. of Test
Hand Penetrometer Test	61	Unconfined Compressive Test	17
Moisture Content Test	66	Percent Soil Particles Passing a No. 200 Sieve	16
Atterberg Limits	24	One-Dimensional Consolidation Test	1
Dry Density Test	17		

The tests noted above were performed to establish the index properties and to aid in the proper classification of the subsurface soils. The test results are shown on the soil boring logs and consolidation test report and are presented on Plate Nos. 3 through 10.

III. GENERAL DESCRIPTION OF SUBSURFACE MATERIALS

The specific subsurface stratigraphy as determined by the field exploration is shown in detail on the soil boring logs herein. However, the stratigraphy can be generalized as follow:

STRATUM NUMBER	RANGE OF DEPTH, Ft.	SOIL DESCRIPTION
I	0' – 1'	5.75 to 8.0 inches of Concrete Pavement over 6.0 inches of Base Material (Lime Stabilized Material)
II	0' – 6'	Possible Fill Material, firm to hard, dark gray, gray, light gray, tan, and reddish brown FAT CLAY and LEAN CLAY WITH SAND
III*	2' – 13'	Stiff to very stiff, gray, light gray, tan and reddish brown FAT CLAY (CH)

IVa*	13' – 20'	Stiff, tan, light gray, and reddish brown LEAN CLAY (CL) and SANDY LEAN CLAY (CL) (not encountered in Boring Nos. B-2, B-3, and B-7)
IVb*	13' - 18'	Medium dense, tan and light gray SILTY SAND (SM) and SANDY SILT (ML) (encountered in Borings B-2 and B-3)
V*	16' - 30'	Very stiff, reddish brown, light gray, and tan FAT CLAY (CH). (Not encountered in Boring B-8)

*Classification is in accordance with the Unified Soil Classification System

Laboratory testing was performed on selected samples of the subsurface materials obtained to classify the soils in accordance with ASTM D 2487 and to define the engineering properties of the soils.

The existing possible fill materials from ground surface to 6 feet below the surface have a moisture content ranging from 17 to 41%, liquid limits ranging from 40 to 55, plasticity index (PI) ranging from 25 to 35, and a percent passing the No. 200 sieve of 78.

The upper CH fat clayey soils have moisture contents ranging from 27 to 38%, liquid limits ranging from 53 to 94, and plasticity indices (PI) ranging from 35 to 67, percent passing the No. 200 sieve ranging from 89 to 92.

The CL clayey soils have moisture contents ranging from 20 to 26%, liquid limits ranging from 26 to 36, and plasticity indices (PI) ranging from 7 to 20 and percent passing the No. 200 sieve ranging from 51 to 93.

The sandy silt soils have moisture contents of 21, and 63 percent passing the No. 200 sieve.

The lower CH fat clayey soils have moisture contents ranging from 21 to 35%, liquid limit of 72, and plasticity index (PI) of 46, percent passing the No. 200 sieve of 97.

Swell Potential

The CH fat clayey subsoil would then be described as having a high to extremely high shrink/swell potential; and the CL clayey subsoil would then be described as having a low to moderate shrink/swell potential.

Based on the Test Method TEX-124-E by Texas State Department of Highways and Public Transportation, Materials and Tests Division, the soils at this site have a potential vertical rise (PVR). The results of the PVR calculation are presented in the table below:

DEPTHS OF STRUCTURAL SELECT FILL, ft	POTENTIAL VERTICAL RISE (PVR), inches			
	EXISTING	DRY	AVERAGE	WET
Existing Soil	4.2	4.7	3.7	2.3
2	3.5	4.1	3.1	2.0
4	2.1	2.7	1.9	1.2
6	1.5	2.0	1.3	0.8
8	0.5	1.1	0.6	0.4

For this table the structural select fill is defined as sandy lean clay with a liquid limit that does not exceed 35, a plasticity index between 10 and 18.

The actual thickness of select fill to be used should be finalized by the design engineers based on topography and PVR requirements of the structural design and other client/project requirements. Positive drainage should be maintained all around the building at all times.

GETI understands that the PVR is to be 1.0 inch or less. In lieu of using 8 ft of structural select fill to achieve a PVR of less than 1.0 inch, this PVR can be achieved by excavating to a depth of 6 ft, lime stabilize 8 inches of the cut grade, and backfilling with 6 ft of compacted structural select fill with the previously defined properties.

IV. FOUNDATION RECOMMENDATION

1. Foundations and Risks:

The foundations are designed and constructed on the basis of economics, risks, soil type, foundation shape and structural loading. Many times, due to economic considerations, higher risks are accepted in foundation design. It should be noted that some levels of risk are associated with all types of foundations. All of these foundations must be stiffened in the areas where expansive soils are present and trees should be removed prior to construction.

2. Foundation Discussion:

In general, the foundation for the structures must satisfy two independent criteria. First, the maximum design pressure exerted at foundation levels should not exceed the allowable net bearing pressure based on an adequate factor of safety with respect to soil shear strength. Second, the magnitude of total and differential settlements or heave under sustained foundation loads must be such that the structure movement is within tolerable limits.

Various types of foundation such as Slab-on-Grade, Spread Footings, Underreamed Drilled (Belled) Footings, and Straight Shaft Footings etc. have been discussed for the support of the proposed structure. Based on the field investigation and laboratory test results, the soils are clayey sand, sandy clay and clay having a low to very high shrink/swell potential. Details of soil strata are given in soil boring logs, Plate Nos. 3 through 10. In our opinion, for this type of soil strata both Underreamed Drilled (Belled) Footings and Shallow Foundation Design (Spread Footing) are considered suitable foundation systems. Details are given in the following sections.

2.1 Underreamed Footings (Drilled Piers)

Based on the soil condition revealed by the field soil test borings and laboratory tests, it is our understanding that the buildings at the site can be supported on a foundation system comprised of drilled underreamed footing bearing at a depth of eleven (11) feet below existing grade in the layer of firm to stiff dark gray clay for the building, and very stiff gray and light gray clay for the garage. The footings for the garage may be sized for a net allowable bearing pressure of 4,500 psf for dead load plus sustained live load; whereas, the footings for the building may be sized for a net allowable bearing pressure of 3,250 psf for dead load plus sustained live load. The maximum pier diameter is defined as 8 feet to limit settlement to approximately 1.0 inch. The net allowable bearing pressures contains a factor of safety of 2. Spacing between the centers of the two adjacent footings should be at least 3 times of the bell diameter. Should the spacing be reduced, a group action reduction factor can be applied to estimate a reduced net allowable bearing pressure.

Bell Diameter to Spacing Ratio, D_b/S	Normalized Group Action Reduction Factor*
0.33	1.00
0.55	0.90
0.60	0.88
0.65	0.86

* Note: Factors based on Converse-Labarre Formula applied to a line of piers.

The plinths of underreamed footing should be reinforced with sufficient reinforcing (tension) steel to resist the potential tension force caused by uplift loads due to expansive soils between the depth of seasonal moisture changes nine (9) feet and the final ground surface elevation. An adhesion value of 0.7 tsf should be applied to the straight shaft portion of the drilled footings below 5 feet for computation of uplift loads.

Caving of soils around the footings may occur during construction of the drilled piers due to the presence of sands. In case the bell on the drilled footings cannot be constructed due to the occurrence of caving, it is recommended that the construction contractor should use cased piers or convert from Underreamed footings to Straight shaft footings immediately. The bottom of the piers should be dry and clean. If water encounters during installation, it should be pumped out prior to concrete placement. We recommend that the drilling be performed under the supervision of a qualified representative of the Geotechnical Engineer.

Experience indicates that underreams can be successfully installed and based on local practice for performing underreamed drill pier is to utilize 3.0 to 1.0 for underream to shaft ratio. Should caving occur during belling operation, the shaft diameter may have to be increased, thereby changing the bell to shaft ratio. If the soil conditions warrant the changing of the shaft diameter, the structural engineer of record should be informed about any changes, because they may require a change in reinforcing steel or bell diameter. Another alternative, would be to change the typical 45 degree angle of the underreamed to 60 degree. The concrete should be placed in a timely manner after drilling to minimize the potential for caving of the foundation soils.

Inspection during Construction of Drilled Piers:

The recommendations are based on the subsoil data in the field exploration and laboratory testing. Due to the geological deposition of the Pleistocene soils in the Gulf Coastal area, variances may occur between boring locations, therefore, the footing excavations should be inspected under the supervision of a qualified representative of the geotechnical engineer to confirm that the bearing soils are similar to those encountered in our field exploration and that the footing area have been properly prepared. The geotechnical engineer should be immediately notified if any subsoil condition be uncovered that will alter the conclusions and recommendations contained in this report. Further investigation and supplemental recommendations may be required, if such a condition is encountered.

Prior to placement of concrete, the footings should be inspected to monitor that:

1. The footing bears in the proper bearing strata at the depth recommended in this report.

2. The footing shafts are of the proper dimensions and reinforcing steel is placed as shown on the structural drawings.

3. The footings are concentric with the shaft and the shaft has been drilled plumb within specified tolerances.

4. Excessive cutting, build up of cutting, and any other soft compressible materials have been removed from the bottom of the excavations.

Floor Slab Options
There may be two options for floor slab:

a) Slab supported by piers only: in this option, slab is supported by only grade beams, which are supported by piers. In this case, loads are applied on only piers. Slab should be raised from the ground surface by at least six (6) inches to avoid the vertical displacement of the slab. The slab should be tied and stiffened with grade beams. The grade beams should have six (6) inches void boxes beneath them. Details for void boxes are given below in the section "Void Boxes".

b) Slab supported by grade beams and sub-grade: Another option is that the slab may be supported by the grade beams and the sub-grade (soil beneath the slab). For this option the surficial soil containing roots, organic and unsuitable materials should be stripped off and replaced by Structural select fill materials having a liquid limit less than 35 and a plasticity index

(P.I.) between 10 and 18 to control vertical displacement corresponding to the previously estimated PVR values. The structural select fill materials should be filled according to the procedures prescribed in the section "Structural Fill and Subgrade Preparation". With six (6) feet of structural select fill supported on 8 inches of lime stabilized excavation subgrade soil, the uplift pressure on grade beams are not likely to exceed 1,500 psf. (Laboratory tests should be conducted to acquire a more exact value.)

Void Boxes

A void/crawl space of six (6) inches may be provided beneath the grade beams. This void space allows for movement of the expansive soils below the grade beams without distressing the structural system. Structural cardboard void forms are often used to provide this void space.

Void Boxes are typically placed under the grade beams to provide this void space, and act as a barrier separating the grade beams from the expansive soils. The purpose for using the void boxes is when the underlying expansive soils swell, the void boxes will then collapse, thus minimizing the uplift loads caused from the expansive soils on the grade beams.

If surface water is not properly drained, these voids may act as a channel for water to travel under a foundation system with poor area drainage, however, if this condition occurs, it may result in the subsequent swelling of the soils and an increase in subsoil moisture loads on the floor slabs. It is our opinion that the determination whether or not to provide voids under the grade beams be made by the owner, builder, engineer or architect after both the positive and negative aspects are evaluated. Geoscience Engineering & Testing, Inc. from our experience with these voids, as well as the experiences of other experts, brings us to the conclusion that even though they may be effective in reducing swell pressures on the grade beams, they may provide free water that would be available for absorption by slab support soils.

2.2 <u>Shallow Foundation Design Parameters</u>

Based on the soil condition revealed by the field soil test borings and laboratory tests, it is our understanding that the buildings at the site can be supported on a foundation system comprised of spread footings bearing at a depth of four (4) feet below existing grade supported on four (4) feet of cement stabilized sand fill bearing on natural soil at a depth of eight (8) feet below the existing grade. Flowable Fill is a Controlled Low Strength Material (CLSM) that may be used in lieu of cement-stabilized sand.

The spread footings should be designed for maximum allowable net bearing pressures of 2,600 psf for axial compression dead loads plus sustained loads and 3,900 psf for axial compression dead loads plus sustained and transient live loads. These capacity values include factors of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading, respectively. Footing weight below final grade can be neglected in the determination of design loading.

The settlement analyses using a bearing pressure of 2,600 psf is about 2.0 inches.

In general, site preparation should consist of removing any grass, weeds and undesirable materials. The exposed subgrade should be proof-rolled to detect local weak areas that should be excavated, processed and re-compacted in loose lifts of approximately eight-inch thickness. In floor slab, subgrade soils should be compacted to a minimum of 95% of standard proctor Density Test (ASTM D-698) at moisture content within -1% to + 3 % of optimum moisture. Tree stumps, if present, should be removed below floor slab grade and backfill with structural select fill materials.

Spread footing foundation should be prepared in accordance with the following recommendations.

- Excavate the soils to a depth of at least 4.0 feet beneath the foundation grade elevation and a width of at least 3 feet beyond the edges of the foundation.

- Compact the exposed subgrade soils to an in-place dry density equal to a minimum of 95 percent of the maximum dry density as per ASTM D-698. The moisture content should be with -1% to +3% of optimum moisture. An appropriate compactor should be used to perform the compaction.

- Place at least 4.0 feet of properly compacted cement stabilized sand for a width of at least 3 feet beyond the edges of the foundation. The cement stabilized sand material fill should be placed in 8-inch loose lifts and compacted to a minimum of 95 percent of the maximum dry density as per ASTM D 558, and should have a 7-day compressive strength that exceeds 100 psi. (In lieu of cement stabilized sand, flowable fill may be used with the a compressive strength that exceeds 100 psi.)

We recommend that the excavating and placing of the cement stabilized sand or flowable fill be performed under the supervision of a GETI representative or a qualified representative of the Geotechnical Engineer

Sides of excavations deeper than about 5 feet or those cut in sand should be braced, either such as with a protective-trench box, sheeting or sloping. The contractor should provide a safety system meeting the requirements of the latest edition of Occupational Safety and Health Administration (OSHA) Regulations 1926, Subpart P.

3. Earth Pressure Design Parameters for Structures below Ground Surface

The structures below the ground surface at the proposed site may be designed by using the following design parameters:

SITE SOILS	WEIGHTOF EQUIV. FLUID FOR ACTIVE CASE (PCF)	WEIGHTOF EQUIV. FLUID FOR PASSIVE CASE (PCF)	ACTIVE EARTH PRESSURE COEFFICIENT (K_A)	PASSIVE EARTH PRESSURE COEFFICIENT (K_P)	EFFECTIVE STRESS ANGLE OF INTERNAL FRICTION (°)*	EFFECTIVE STRESS COHESION (PSF)*	WET UNIT WEIGHT (PCF)
CH Clay Soils	94*	204*	0.53	2.34	18	200	123
CL Clay Soils	94*	228*	0.49	2.60	20	250	126

* **The weights of equivalent fluid include hydrostatic forces and do not include surcharge forces imposed during construction equipment or vehicular loadings. Surcharge forces should be considered in order to compute maximum stresses for use in the design of the structures below the ground surface.**

It is recommended that for design purposes, a factor of safety of 2 be applied to the weights of equivalent fluid for the passive case and the passive earth pressure coefficients. With the use of a safety factor of 2, the weight of equivalent fluid for the passive case will be 157 pcf and 168 pcf for the site fat clay and lean clay soils, respectively. The passive earth pressure coefficient will be 1.56 and 1.70 for the site fat clay and lean clay soils, respectively.

4. IBC Seismic Designation:

The IBC table 1613.5.2 seismic designation for the soils encountered at this project site in Houston, Texas is class D.

V. GENERAL CONSTRUCTION CONSIDERATIONS

1. Site Preparation:

Our recommendations for site preparations in the floor slab are summarized below:

1.1 In general, remove all concrete pavement area, base material, vegetation, tree roots, organic topsoil and any undesirable materials from the construction area. Tree trunks and roots under the floor slabs should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

1.2 Any on-site fill soils, encountered in the structure areas during construction, must have records of successful compaction tests signed by a registered professional engineer that confirms the use of the fill and record of construction and earthwork testing. These tests must have been performed on all the lifts for the entire thickness of the fill. In the event that no compaction test results are available, the fill soil must be removed, processed and recompacted in accordance with our recommendations of "Structural Fill and Subgrade Preparation". Excavation should extend at least five (5) feet beyond the structure area. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

1.3 The subgrade areas should then be proof-rolled with a 15-ton roller, or other equivalent suitable equipment as approved by the engineer. The proof-rolling serves to compact surficial soils and to detect any soft or loose zones. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. The proof-rolling operations should be observed by an experienced geotechnician.

1.4 We recommend that the site and soil conditions used in the structural design of the foundation be verified by the engineer's site visit after all of the earthwork and site preparation has been completed prior to the concrete placement.

2. Structural Fill and Subgrade Preparation:

It is recommended that the subgrade and fill be prepared as follow:

2.1 The site should be stripped to suitable depth to remove concrete pavement area, base material, any top soil and miscellaneous fill material. The exposed subgrade surface then should be proof-rolled. All soft or loose soils should be removed and replaced with select fill materials.

2.2 The natural subgrade should be scarified to a minimum depth of six (6) inches. The scarified soils should then be recompacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM-D 698). The moisture content should range -2% to +3% of optimum moisture.

2.3 Structural Select fill used to elevate the grade should consist of a clean Sandy Clay with Liquid Limit less than 35 and a Plasticity Index (P.I.) between 10 and 18.

2.4 The Structural Select fill material should be placed in maximum of eight (8) inch loose lift and compacted to a minimum of 95 percent of the maximum dry density as per ASTM D-698. The moisture content should be with -1% to +3% of optimum moisture.

2.5 In cut areas, the soils should be excavated to grade and the surface soils proof-rolled and scarified to a minimum depth of six inches and recompacted to the previously mentioned density tests at the time of construction.

3. Surface Drainage:

It is recommended that the site drainage be well developed. Surface water should be directed away from the foundation soils (use a minimum of 2% with 10 feet away of foundation). No ponding of surface water should be allowed near the structure. The following drainage precaution should be observed during construction and at all times after the structure has been completed.

1. Backfill around the structure should be a cohesive soil material that should be moistened and compacted to at lease ninety (90) percent of standard proctor density. Any cohesionless soil

material accumulated around the perimeter of the structure during construction should be removed and not allowed to be mixed with or covered by the backfill material.

2. Where landscaping is to be installed next to the perimeter of grade beam, a moisture barrier or other suitable means should be installed to prevent moisture from entering the underlying clay soils.

3. Roof downspouts and drains should discharge well away from the limits of the foundation or grade beams.

4. Vegetation Control:

We recommend trees not to be closer than half the canopy diameter of the mature tree from the grade beams, typically a minimum of 20 feet. This will minimize possible foundation settlement caused by the tree root systems.

VI. DISCLAIMER

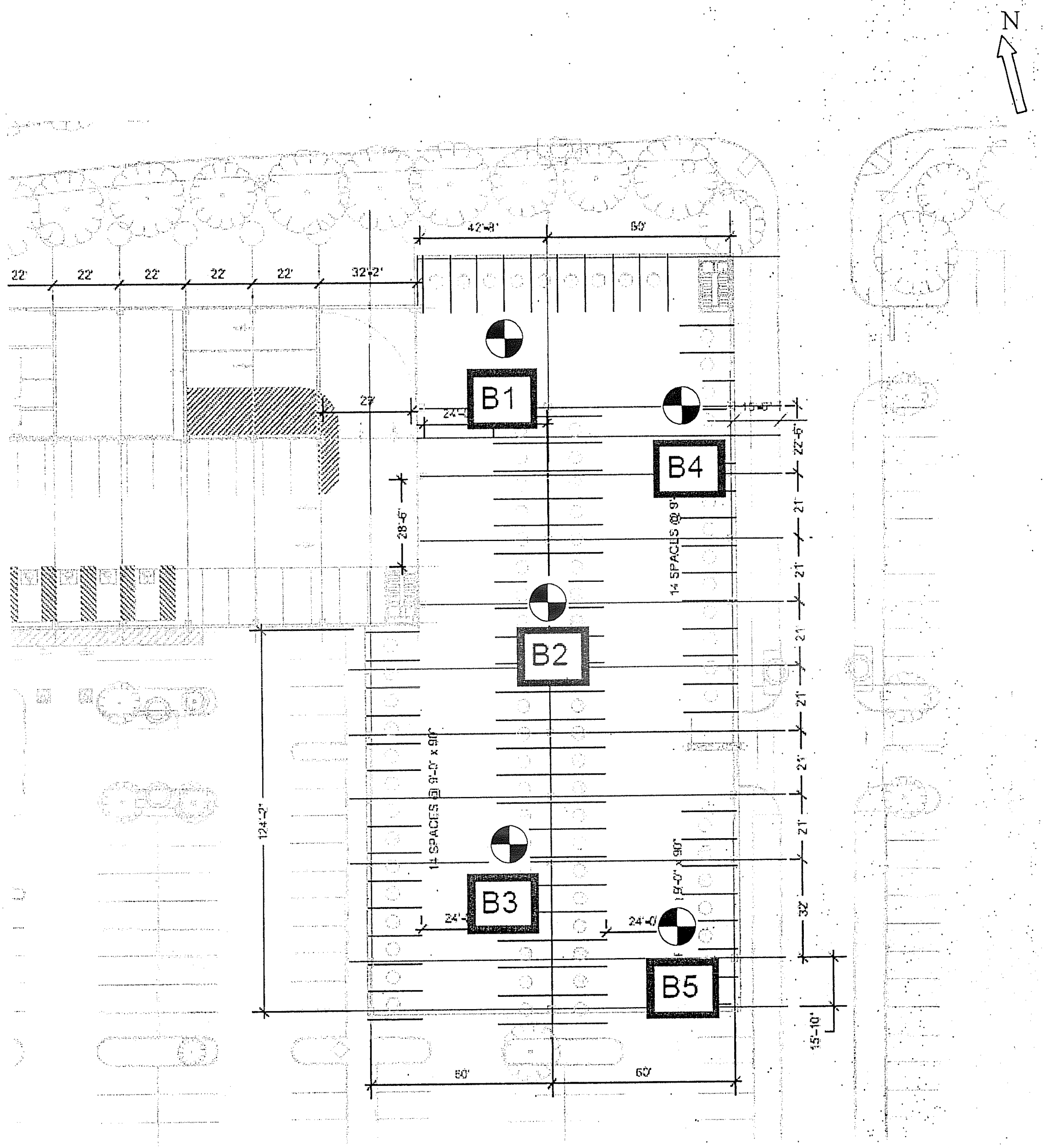
The information and recommendation contained in the report summarized condition found at the site of the proposed VA Vertical Expansion Building 108 and Parking Garage B located at 2002 Holcomb Boulevard in Houston, Texas, specified and on the date that the field exploration was completed. The attached soil boring logs are a true representation of the soils encountered at the stratigraphy as found during the field exploration and drilling of the subject site.

Reasonable variations from the subsurface information presented in this report are assumed. If condition encountered during construction are significantly different than those presented in this report, GETI should be notified immediately.

The report was prepared for the sole and exclusive use by our client, based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, and other documents prepared by GETI as instruments of service shall remain the property of GETI. Reuse of these documents is not permitted without written approval by GETI. GETI assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

In addition, the construction process may itself alter site soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures and all conditions encountered. We recommend that the owner retain Geoscience Engineering and Testing, Inc. to provide this service as well as the construction material and testing and inspection required during the construction phase of the project. We would welcome the opportunity to discuss our recommendation with you and hope we may have the opportunity to provide any additional studies or service to complete this project. The following illustrations are attached and complete this report:

ILLUSTRATIONS	PLATE NUMBERS
Boring Location Plan	1
One-Dimensional Consolidation Test	2
Boring Logs	3-10
Symbols and Terms used on Boring Logs	11

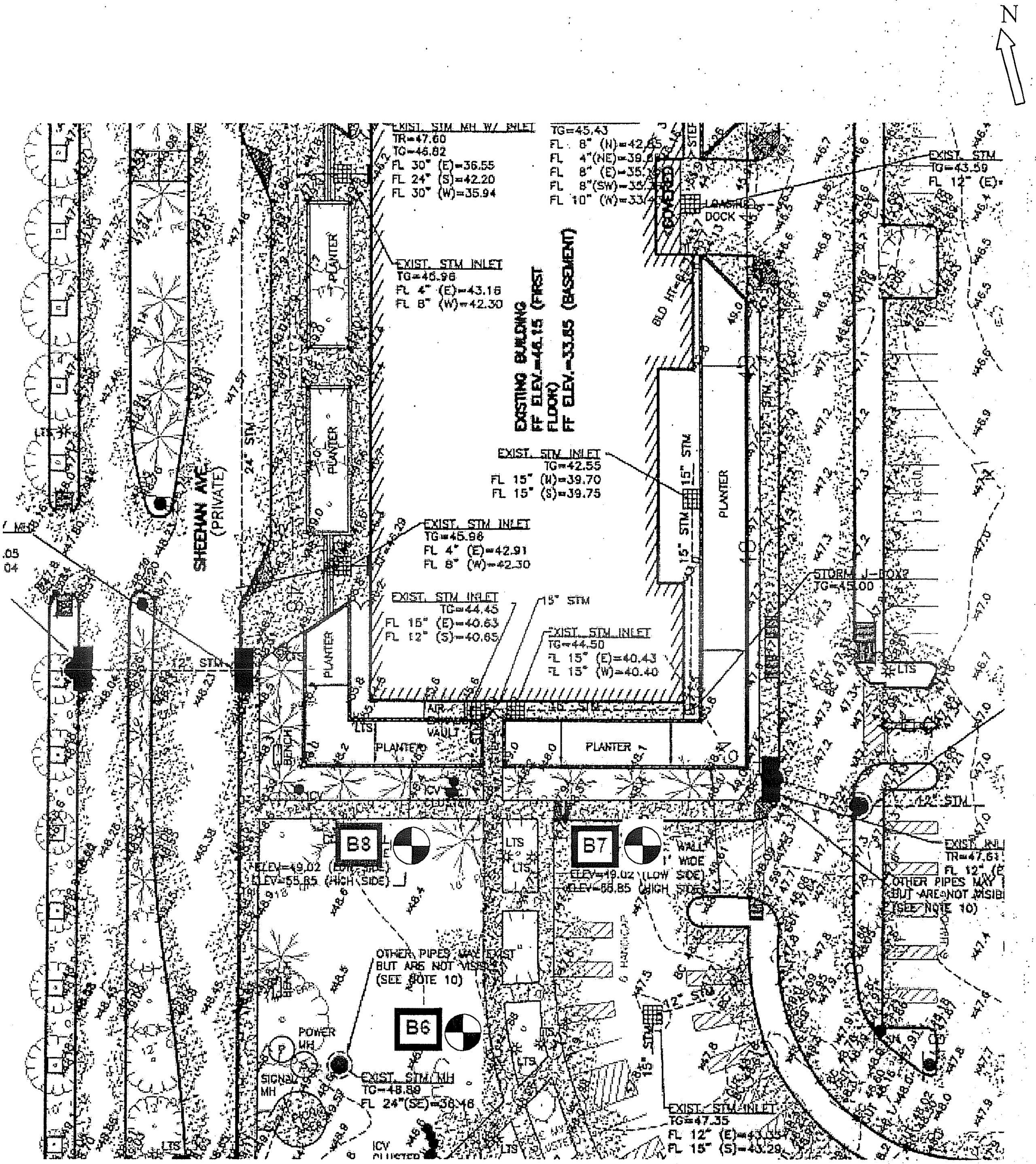


Approximate Boring Locations

<u>LOCATION (Parking Garage B)</u>
VA Expansion Building 108 and Parking Garage B
2002 Holcombe Boulevard
Houston, Texas
GETI NO.: 12G19759

NOT TO SCALE

PLATE NO. 1A



Approximate Boring Locations

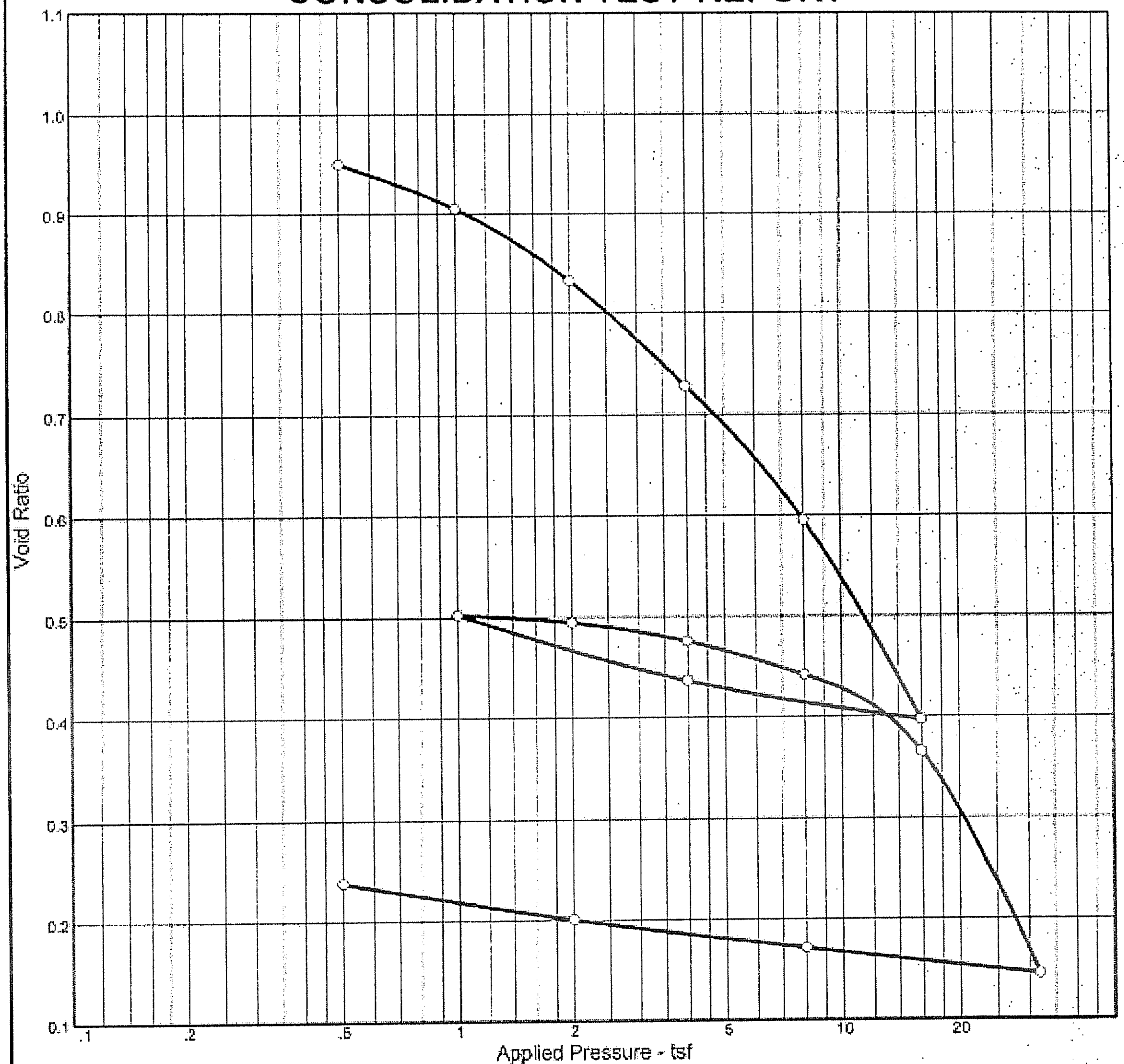
LOCATION (Building 108)
VA Expansion Building 108 and Parking Garage B
2002 Holcombe Boulevard
Houston, Texas
GETI NO.: 12G19759

NOT TO SCALE

PLATE NO. 1B

GEOSCIENCE ENGINEERING & TESTING, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
100.0 %	34.9 %	87.6	94	67	2.75		10.18	0.84	0.09	0.959

MATERIAL DESCRIPTION	USCS	AASHTO
FAT CLAY	CH	N/A

Project No. GETI12G19759 **Client:** Geoscience Engineering and Testing, Inc.

Project: VA Expansion Building and Parking Garage

Source: **Sample No.:** Boring B-6 **Elev./Depth:** 8'-10'

HTS, INC.

Remarks:

Tested By: IT
Date: 05/14/12
Checked By: GEV
Date: 05/17/12

Figure Plate 2

VA Expansion Building 108 and Parking Garage B
2002 Holcombe Boulevard
Houston, Texas
GETI NO.: 12G19759

PLATE NO. 2

PROJECT: VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-1** DEPTH **30'**
CLIENT: PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	PROJECT NO. 12G19759 DATE: April 22, 2012
	Water was encountered **during drilling operation at a depth of 16' below the surface.**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

FIELD DATA / LABORATORY DATA

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT, T: INCHES/100 BLOWS, P: TONS/SQ FT, RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
											5.75" Concrete Pavement over 6" Base material (Lime Stabilized)
			P=4.0	34							Possible Fill, stiff, tan, dark gray, and gray FAT CLAY
			P=2.5	27							very stiff, gray and light gray FAT CLAY (CH) with sand pockets
5			P=2.0	31	97	85	22	63	89	0.80	- stiff at 4' - very stiff tan and light gray at 6'
			P=2.5	36							
			P=3.5	30							- stiff reddish brown and light gray at 8'
10											
			P=1.75	26	99	35	15	20	93	0.70	Stiff, reddish brown LEAN CLAY (CL) with silt pockets and sand fissures
15											**16'**
											Very stiff, reddish brow and light gray FAT CLAY (CH)
			N=26	32							
20											
			P=3.0	26							
25											
			P=3.5	29							
30											**Boring Terminated at 30'**

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
B - SAMPLE RECOVERED FROM THE AUGER

GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 3

PROJECT: VA Vertical Expansion Building 108 and Parking garage BB 2002 Holcombe Boulvard Houston, Texas **CLIENT:** PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	BORING NO.: **B-2** DEPTH **30'** PROJECT NO. 12G19759 DATE: April 22, 2012 Water was encountered **during drilling operation at a depth of 16' below the surface.**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend: Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT T: INCHES/100 BLOWS P: TONS/SQ FT RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
											6.5" Concrete Pavement over 6" Base material (Lime Stabilized)
			B	41							Possible Fill, tan, dark gray, and gray FAT CLAY
			P=2.5	31		89	25	64	91		Very stiff, gray and light gray FAT CLAY (CH) with sand pockets
5			P=2.75	27							
			P=2.75	27							- tan and gray at 6'
			P=2.75	32	93	76	24	52	92	1.00	- stiff reddish brown and light gray at 8'
10											
			P=2.75	27							
15											**16'**
											Reddish brown SILTY SAND (SM)
			N=21	29							Very stiff, reddish brown and light gray FAT CLAY (CH)
20											
			P=3.0	33							
25											
			P=3.5	29							
30											**Boring Terminated at 30'**

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GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 4

PROJECT: VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-3** DEPTH **30'** PROJECT NO. 12G19759 DATE: April 22, 2012
CLIENT: PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	Water was encountered **during drilling operation at a depth of 16' below the surface.**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

DEPTH (FEET)	N: BLOWS/FT / T: INCHES/100 BLOWS / P: TONS/SQ FT / RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
									5.75" Concrete Pavement over 6" Base material (Lime Stabilized)
	B	41							Possible Fill, tan, dark gray, and gray FAT CLAY
	P=1.5	28							Stiff, gray and light gray FAT CLAY (CH) with sand pockets
5	P=2.5	32							- very stiff below 4'
	P=2.25	33	88	84	25	59	91	0.70	- light gray and light tan at 7'
	P=3.0	27							- stiff reddish brown and light gray at 8'
10									
	P=1.5	21		22	20	2	63		Medium dense, tan and light gray SANDY SILT (ML) with clay pockets
15									**16'**
	P=2.75	28	97	72	26	46	97	1.00	Very stiff, reddish brown and light gray FAT CLAY (CH) with calcareous nodules
20									
	P=2.75	35	88					1.00	
25									
	P=3.0	33							
30									**Boring Terminated at 30'**

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GEOSCIENCE ENGINEERING & TESTING, INC.

PROJECT: VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-4** DEPTH **30'**
CLIENT: PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	PROJECT NO. 12G19759 DATE: April 22, 2012
	Water was encountered **during drilling operation at a depth of 16' below the surface.**

FIELD DATA | LABORATORY DATA | DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend: Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

DEPTH (FEET)	N: BLOWS/FT / T: INCHES/100 BLOWS / P: TONS/SQ FT / RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
									8" Concrete Pavement over 6" Base material (Lime Stabilized)
	P=2.75	30							Possible Fill, gray and light gray FAT CLAY
	P=2.75	27	98	75	23	52		1.00	Very stiff, gray and light gray FAT CLAY (CH) with sand pockets
5	P=2.75	27							- light gray and light tan at 4'
	P=2.75	29	95	88	27	61		0.70	- with crawfish holes from 6 to 8'
	P=2.75	38	86	83	28	55		0.50	- stiff reddish brown and light gray at 8'
10									
15	P=1.75	25					67		Stiff, tan and light gray SANDY LEAN CLAY (CL) with sand layers
									16'
									Very stiff reddish brown and tan FAT CLAY (CH)
20	P=3.0	27							
25	P=3.0	29							
30	P=3.0	31							**Boring Terminated at 30'**

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P- POCKET PENETROMETER RESISTANCE
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GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 6

PROJECT: VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-5** DEPTH **30'**
CLIENT: PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	PROJECT NO. 12G19759 DATE: April 22, 2012
	Water was encountered **during drilling operation at a depth of 16' below the surface.**

FIELD DATA / LABORATORY DATA

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

SAMPLES: N: BLOWS/FT, T: INCHES/100 BLOWS, P: TONS/SQ FT, RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	ATTERBERG LIMITS (%) LL (LIQUID LIMIT)	PL (PLASTIC LIMIT)	PI (PLASTICITY INDEX)	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
								6.0" Concrete Pavement over 6" Base material (Lime Stabilized)
B	24							Possible Fill, hard dark gray FAT CLAY
P=4.5	30							
P=2.25	29							Very stiff, gray and light gray FAT CLAY (CH)
P=2.75	27	95	79	22	57		0.80	
								- stiff reddish brown and light gray at 8'
P=2.5	32							
P=1.5	24	104	26	19	7	75	0.40	Stiff, tan and light gray LEAN CLAY WITH SAND (CL) with sand layers
								16'
P=3.0	35							Very stiff, reddish brown and light gray FAT CLAY (CH)
P=4.0	25							
								- tan and light gray at 28'
P=3.5	29	98					1.00	
								Boring Terminated at 30'

DEPTH (FEET): 5, 10, 15, 20, 25, 30

N- STANDARD PENETRATION TEST RESISTANCE
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GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 7

PROJECT:	VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-6**	DEPTH **20'**
CLIENT:	PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	PROJECT NO. 12G19759	DATE: April 14, 2012

Water was encountered **during drilling operation at a depth of 16' below the surface.**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

		FIELD DATA	LABORATORY DATA		ATTERBERG LIMITS (%)					
DEPTH (FEET)	SOIL SYMBOL / SAMPLES	N: BLOWS/FT T: INCHES/100 BLOWS P: TONS/SQ FT RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
										7.0" Concrete Pavement over 6" Base material (Lime Stabilized)
		P=2.75	18		55	20	35			Possible Fill, very stiff, reddish brown and light gray FAT CLAY (CH) with ferrous nodules
		P=1.5	25							-stiff from 2' to 4'
5		P=2.0	31		78	26	52			Siff, gray FAT CLAY (CH) with roots - very stiff gray and light gray with ferrous stains at 6'
		P=2.5	27		72	26	46			
		P=1.5	36		94	27	67			- stiff reddish brown and light gray at 8' - consolidation parameters, C_c=0.84, C_r=0.09, e_o=0.959, P_c=10.18 tsf (see Plate 2)
10										
		P=1.5	20	87	31	20	11	51	0.10	Stiff, tan and light gray SANDY LEAN CLAY (CL) with sand pockets
15										16'
										Very stiff, reddish brown and light gray FAT CLAY (CH)
		P=2.5	21							
20										**Boring Terminated at 20'**
25										
30										

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GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 8

PROJECT:	VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: B-7	DEPTH 20'
CLIENT:	PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	PROJECT NO. 12G19759	DATE: April 14, 2012

Water was encountered **during drilling operation at a depth of 18' below the surface.**

DRILLING METHOD (S): **Continuous Flight Auger & Intermittent Sampling**

Legend: Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT T: INCHES/100 BLOWS P: TONS/SQ FT RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
0–2	Fill		P=2.5	22							Possible Fill, very stff, reddish brown and light gray LEAN CLAY with ferrous nodules
2–4	Fill		P=1.5	20		40	15	25	78		Possible Fill, stiff, tan, dark gray, and light gray LEAN CLAY WITH SAND
4–6	Fill		P=3.0	20		48	16	32			- very stiff at 4'
6–8	Fat Clay		P=1.5	30							Stiff dark gray FAT CLAY (CH)
8–10	Fat Clay		P=2.0	36		75	25	50			- stiff reddish brown and light gray at 8'
13–15	Fat Clay		P=3.5	30	99	65	20	45		1.30	- very stiff reddish brown and light gray with calcareous nodules at 13'
18–20	Fat Clay		P=2.5	23							- tan and light gray with sand layer at 18'
20											**Boring Terminated at 20'**

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P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
B - SAMPLE RECOVERED FROM THE AUGER

GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 9

PROJECT: VA Vertical Expansion Building 108 and Parking Garage B 2002 Holcombe Boulvard Houston, Texas	BORING NO.: **B-8** DEPTH **20'** PROJECT NO. 12G19759 DATE: April 14, 2012
CLIENT: PAGE SOUTHERLAND PAGE, LLP 1100 Louisiana, Suite One Houston, Texas	Water was encountered **during drilling operation at a depth of 16' below the surface.**

DRILLING METHOD (S): **Continuous Flight Auger & Intermittent Sampling**

Legend: Fat Clay, Lean Clay, Silty sand, Fill, Clayey Sand, Sandy Silt

DEPTH (FEET)	FIELD DATA (N: BLOWS/FT, T: INCHES/100 BLOWS, P: TONS/SQ FT, RQD: PERCENT)	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
0–2	P=1.25	17							Possible Fill, stff, reddish brown and light gray LEAN CLAY with ferrous nodules
2–6	P=0.75	31							Possible Fill, firm tan, dark gray, and light gray LEAN CLAY WITH SAND
5	P=0.75	21							
6–13	P=0.75	33	92	53	18	35		0.50	Firm, dark gray FAT CLAY (CH)
	P=1.5	36	89	70	23	47	90	0.60	- stiff reddish brown and light gray at 8'
13–20	P=0.75	26	99	36	17	19	53	0.40	Firm, light gray and tan SANDY LEAN CLAY (CH) with sand pockets
16									- with sand layer at 16 '
18									- light tan and light gray at 18'
	P=0.75	23							
20									**Boring Terminated at 20'**

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GEOSCIENCE ENGINEERING & TESTING, INC.

PLATE NO. 10

KEY TO SOIL CLASSIFICATIO AND SYMBOLS

Gravel (GW, GP, GM, GC)	Clayey Sand (SC)	Sandy Silt (ML)
Sand (SW, SP)	Clayey Silt (ML)	Silty or Sandy Clay (CL)
Silty Sand (SM)	Silt (ML)	Clay (CH)

CONSISTENCY OF COHESIVE SOILS

Description	Shear Strength KSF	Penetration Resistance Blows/ Ft
Very Soft	Less than 0.25	0 - 2
Soft	0.25 - 0.5	2 - 4
Firm	0.5 - 1.00	4 - 8
Stiff	1.00 - 2.00	8 - 15
VeryStiff	2.00 - 4.00	15 - 30
Hard	Greater than 4.00	>30

RELATIVE DENSITY OF COHESIONLESS SOILS

Description	Penetration Resistance Blows / Ft	Relative Density %
Very Loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	>50	85 - 100

Soil Structure

CALCAREOUS NODULES	-- Nodules of Calcium Carbonate
FERROUS NODULES	-- Nodules of Ferrous Material
SLICKENSIDED	-- Having inclined planes of weakness that are slick and glossy
BLOCKY	-- Having inclined planes of weakness that are frequent and rectangular in pattern
LAMINATED	-- Composed of thin layers of varying soil type and texture
FISSURERD	-- Containing shrinkage cracks frequently filled with fine sand
INTERBEDDED	-- Composed of alternate layers of different soil types

Shelby Tube Sample

Standard Penetration Test

Auger or Wash Sample

No Recovery

GROUNDWATER

(24 hOurs) - Water Level after drilling (time increment after drilling)

- Free Water observed during drilling

FAILURE DESCRIPTION (COMPRESSION TEST)

B - Bulge
S - Shear
M/S - Multiple Shear

SLS - Failure surface occuring along slickensided plane
SAS - Failure surface occuring along or in sand seam
SS - Failure surface occuring in or along other secondary structure such as calcareous pockets

PLATE NO: 11